

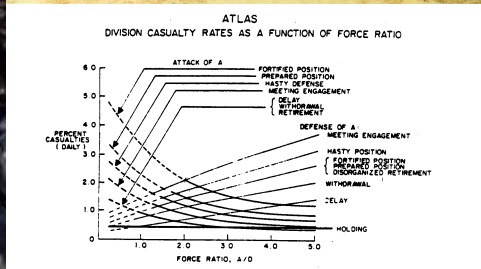
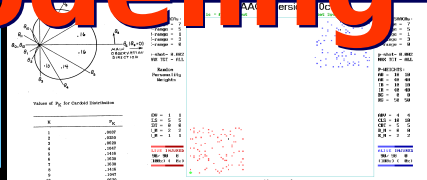
# Modeling and Simulation

## Warfare Modeling

$$\frac{dx}{dt} = -ay$$

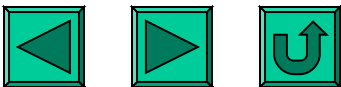
and

$$\frac{dy}{dt} = -bx$$



# Today's Objectives

- **Why are you here?**
- **Course Overview**
  - **Administrative details**
  - **Get connected to course website**
  - **Get marching orders**



# Key Links

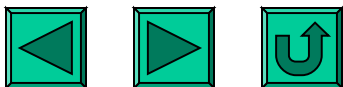
[\*\*http://nps.blackboard.com/\*\*](http://nps.blackboard.com/)

[\*\*http://diana.or.nps.navy.mil/~twlu/cas/\*\*](http://diana.or.nps.navy.mil/~twlu/cas/)



# The Science of Operations Research

- “We help people make better decisions”—NPS Operations Research Department
- “Operations Research is a *scientific* method of providing [decision-makers] with a *quantitative* basis for [*decision-making*]”—Morse and Kimball (first sentence)



# Some Decisions We Analysts Can/Should Help Address

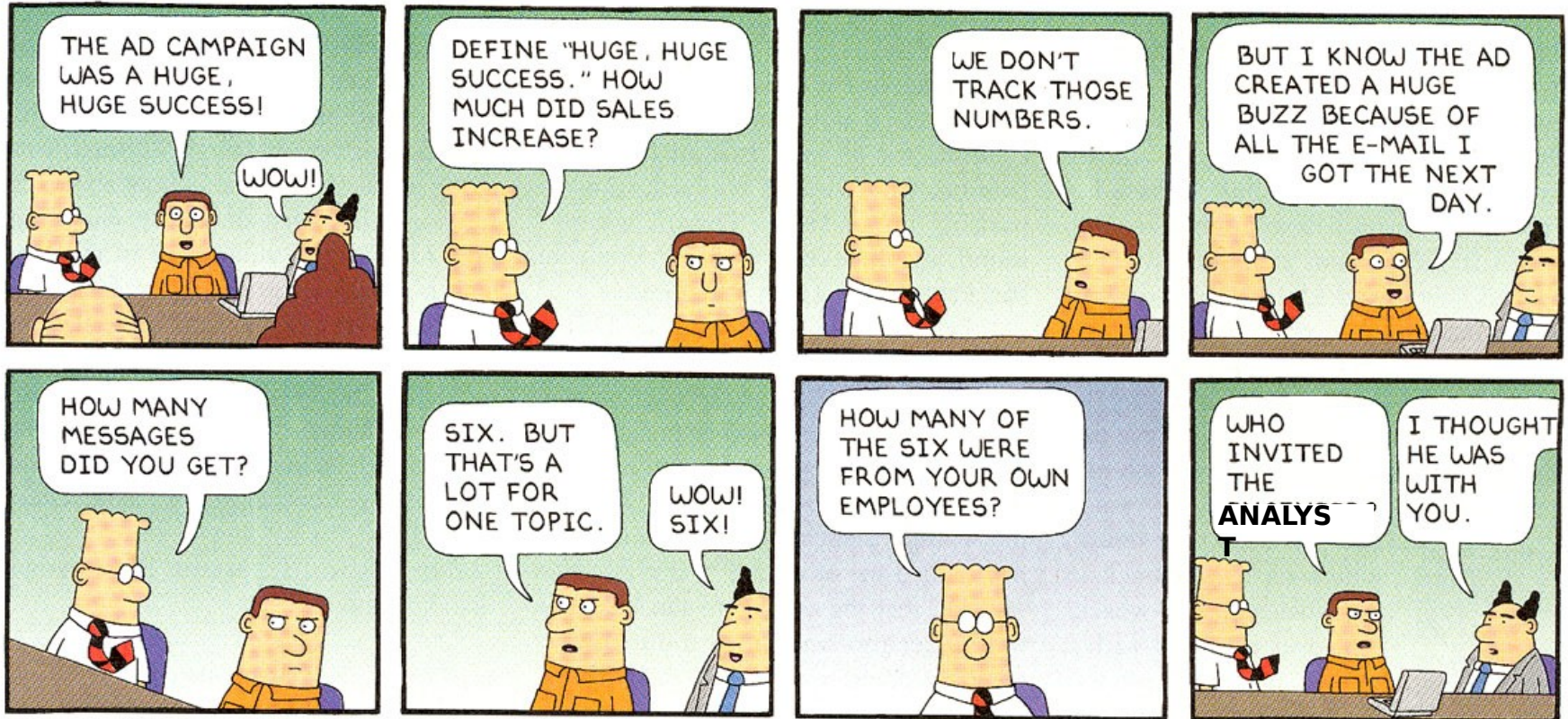
- In Operation Iraqi Freedom, how should the attack proceed? How many soldiers are needed?
  - Course of action analysis/Force employment
- How many B-2's should we buy?
  - Acquisition
- What mix of littoral combat ships, aircraft carriers, etc. should the Navy have in 2020?
  - Force structure
- What tradeoffs should the Navy make in upgrading the F-18 in terms of stealth, weapons, sensors, cost, etc?
  - Force modernization
- What range and lethality of LAM will allow the Navy to effectively support the Marines' vision of "Maneuver From the Sea"?
  - Requirements definition
- How should the Army reorganize its heavy divisions' logistics to take advantage of new information equipment?
  - Force organization





Or, in another example ...

**DILBERT** BY SCOTT ADAMS



# Common Features of These Questions

- Dearth of real-world data with which to use
- Lots of, sometimes conflicting, opinions
- Substantial uncertainties associated with
  - Who, where, when we might fight
  - How well people will perform
  - What equipment will be used and how well will it perform
  - What the weather will be...etc.



# So, We Build Models of Combat

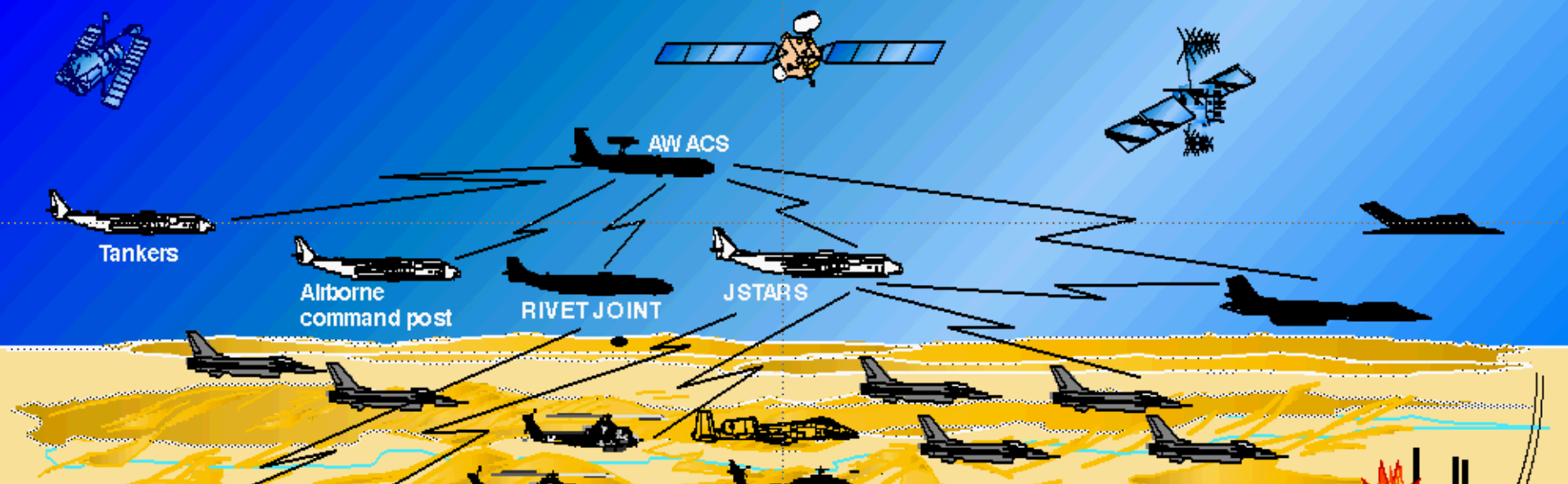
- According to the Defense Modeling and Simulation Office (DMSO) a *model* is “A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon or process.”



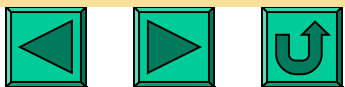
$$\frac{dx}{dt} = -ay \quad \text{and} \quad \frac{dy}{dt} = -bx$$







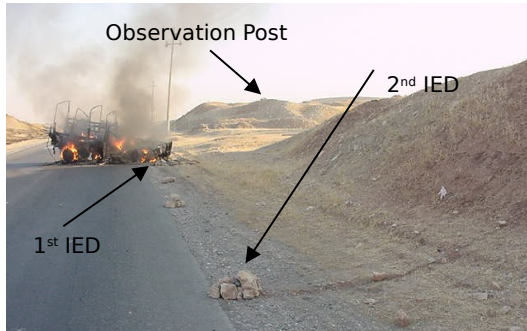
***Simulation*** (a method of implementing a model over time): *The 900 pound Gorilla of Military OR*



***"The idea behind [Monte Carlo simulation]...is to [replace] theory by experiment whenever the former falters—Hammersley and Handscomb***

# From Reality to Model, and Back Again

## Real World



Analysis Team



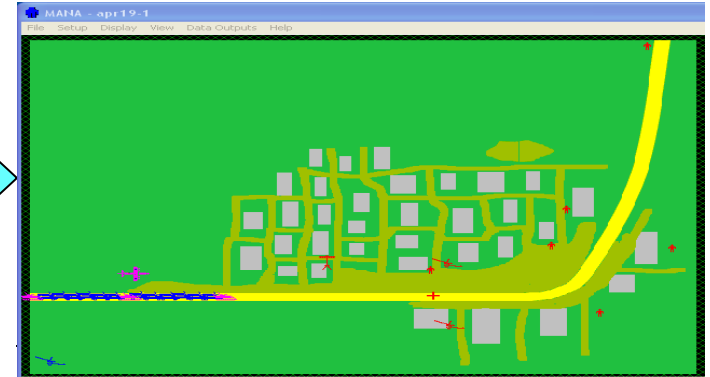
Issues

Questions/hypotheses

Experience/Beliefs

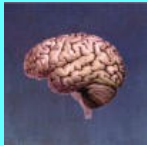
Models/Scenarios

## Model (abstraction of real world)

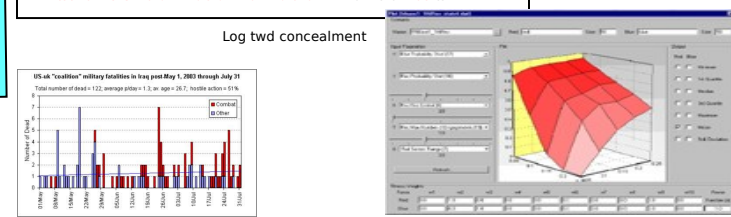
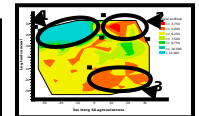
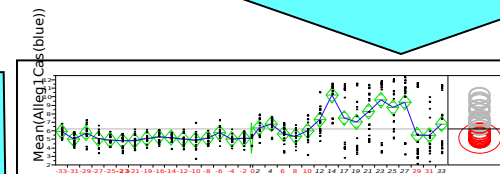
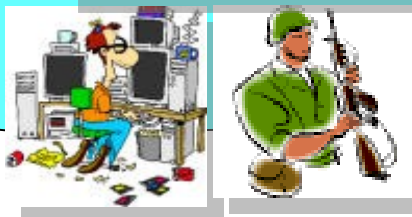


Run/analyze Model

Insights



Analysis Team



# Combat Simulations Have the Potential to Improve Training

- **Potential uses of Combat M&S in training include:**
  - Train in larger scenarios (realistic staff training)
  - Train from home base
    - Can even do distributed mission rehearsal
  - Playback results for AAR
  - Train in conditions that are not feasible for field training because of
    - Safety
    - Security
    - Space
    - Money



# Combat Simulations Have the Potential to Improve

## Test and Evaluation Decision making

- **Potential uses of Combat M&S in Test and Evaluation (T&E) include:**

- Investigate more operating environments
- Extrapolate field test results
- Increase the extent of test scenarios
- Design field tests
- Facilitate “continuous test and evaluation”
- Provide for scientific control & replication
- Evaluate conditions that are not feasible for field tests because of
  - Safety
  - Security
  - Space restrictions



# The Challenge of Combat Modeling

## and Analysis

- *I challenged the Air Staff to model the Desert Storm air campaign after the fact... . With perfect 20-20 hindsight, I asked them to find out why the huge casualty predictions did not come true. They said they couldn't do it because they determined that the Iraqis acted so irrationally that their actions could not be modeled—General Ron Fogleman*
- *Literally, not one purely physics-based model exists in the nation to predict conventional weapons effects on a platform.—James F. O'Bryon, Director of the DOTE's Live Fire Testing*

***The purpose of computing is  
insight, not numbers—Hamming***





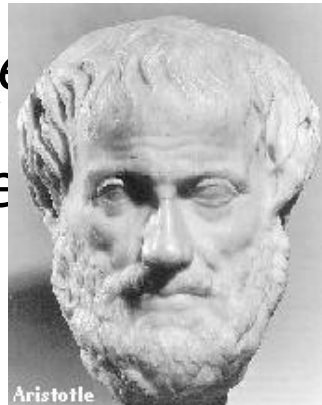
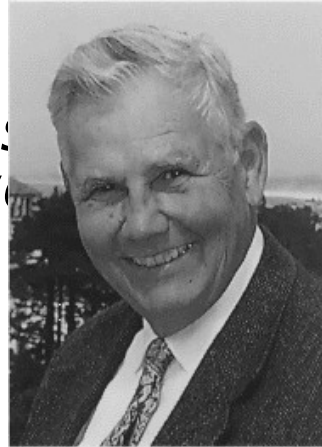
# More Quotes...

- *War is intrinsically unpredictable. At best, we can hope to determine possibilities and probabilities. This implies a certain standard of military judgment...*—Marine Corps Doctrinal Publications, Pub 1, Warfighting
- *It is inappropriate to use models for making predictions about complex systems*—in Making the Nation Safer: The Role of Science and Technology in Countering Terrorism 2002, National Research Council



# How to Think About Force-on-Force Combat Models

- *A combat simulation, no matter how comprehensive and rich in detail, has little or no predictive power*  
—Wayne Hughes
- “***All*** force-on-force combat models leave out important things, but some are useful”
- *A model is useful if a better decision is made with the information it adds*—Wayne Hughes
- *It is the mark of an educated mind to rest satisfied with the degree of precision which the nature of the subject admits and not to seek exactness where only an approximation is possible*—Aristotle



# How to Think About Force-on-Force Combat Models

## II

- The analyst's role is not to provide the answer but...*to provide illumination and visibility—to expose some problem in terms that are as simple as possible*—Lieutenant General Glen Kent
- *Analysis is not to give the answer, but to show how the answer depends on various assumptions and judgments* —Enthovan and Smith
- *[P]rimary benefits of model-based studies are to (1) help explore the issues in a structured way and organize a debate, and (2) uncover new insights and reveal surprising characteristics*—Wayne Hughes
- *Models are for thinking*—Sir Maurice Kendall
- *Modeling is more art than science*—Wayne Hughes



# Some Guiding Philosophy

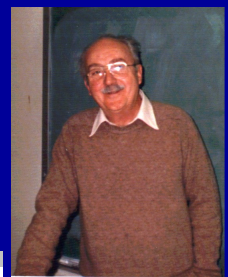
*It's the analyst, not the model, that  
produces important useful results.  
Improve the former before the latter.*

— Seth Bonder



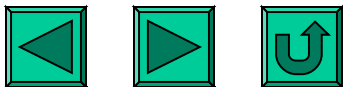
**~~"The  
Model  
Says X"~~**

*All models are wrong, but  
some are useful—George  
Box*



# Course Overview (from Blackboard)

- Course Description
- Learning Objectives
- Grading Policy
- Team Paper Presentation
- Protocols





# Your Next Steps

- Log onto Blackboard, <http://nps.blackboard.com/>
  - Log in
    - If you are having trouble logging on, please e-mail [BbHelp@nps.navy.mil](mailto:BbHelp@nps.navy.mil) .
  - Explore the environment
  - Go to Class Assignment 1 in Blackboard



# Future Additions

- To problems analysts should address
  - Concept exploration
  - DTTP

